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Indian Standard

SPECIFICATION FOR CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES

PART 3 SPECIFICATIONS FOR INDIVIDUAL MATERIALS

Section 5 Special Papers

UDC 621·315·614·61: 676·254

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Gr 7 *July* 1986

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TO

IS 9335 (Part 3/Sec 5) : 1985 SPECIFICATION FOR CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES

PART 3 SPECIFICATIONS FOR INDIVIDUAL MATERIALS

Section 5 Special Papers

(*Page* 6, *Table* 2, *col* 7) — Substitute '0·05' *for* '0·5' in the description of **M1**.

(*Page* 9, *Table* 5, *col* 5) — Substitute 'Tolerance on Nominal Substance' *for* 'Tolerance on Nominal Thickness'.

(*Page* 10, *Table* 5, *Sl No*. 6, *col* 4) — Substitute 'mNm^2/g' *for* '—'.

(*Page* 23, *Table* 8, *Sl No*. 4, *col* 5, *under* '*Symbol*') — Insert '5D81' in the third line.

(*Page* 25, *Table* 8, *Sl No*. 13, *col* 5) — Substitute '5D81' *for* '5D73' and '5D73' *for* '5D82' in the last row.

(ETD 2)

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Indian Standard

SPECIFICATION FOR CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES

PART 3 SPECIFICATIONS FOR INDIVIDUAL MATERIALS

Section 5 Special Papers

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(*Continued on page* 2)

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Indian Standard

SPECIFICATION FOR CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES

PART 3 SPECIFICATIONS FOR INDIVIDUAL MATERIALS

Section 5 Special Papers

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 January 1985, after the draft finalized by the Solid Electrical Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard (Part 3/Sec 5) is one of the series of Indian Standards which deals with cellulosic papers for electrical purposes. This series will have the following three parts:

Part 1 Definitions and general requirements,
Part 2 Methods of test, and
Part 3 Specifications for individual materials.

0.3 This standard (Part 3/Sec 5) covers the requirements of special papers.

The other cellulosic papers are covered in the following sections of this standard:

Section 1 General purpose electrical paper,
Section 2 Capacitor paper,
Section 3 Crepe paper, and
Section 4 Electrolytic capacitor paper.

0.4 In the preparation of this standard, assistance has been derived from IEC Document 15C (Central Office) 142 Specification for cellulosic papers for electrical purposes : Part 3 Specifications for individual materials, Sheet 5 Special Papers issued by the International Electrotechnical Commission.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS : 2 - 1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements for special papers as, for example, those that may be used for cables, transformers and conductor wrapping.

1.2 These papers are particular papers of Class I of IS : 9335 (Part 1) - 1979† with the requirements for specific applications.

NOTE — The examples of use given above indicate three main applications for these papers but do not in any way imply a restriction to such uses, papers of any other class may be employed for such applications when appropriate.

2. DESIGNATION

2.1 The different types of special paper covered by this sheet are designated by the addition of type designating letter A, B, C, etc, to the class designation, for example 5A.

2.2 These special papers are further sub-divided to take account of differing densities, purities and air permeabilities in a manner similar to that used for Class I as given in IS : 9335 (Part 1) 1979†. The details of classification are given in Tables 1 to 4.

3. TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS : 9335 (Part 1) - 1979† shall apply.

4. GENERAL REQUIREMENTS

4.1 The paper shall comply with the general requirements stipulated in IS : 9335 (Part 1) - 1979†.

5. PERFORMANCE REQUIREMENTS

5.1 When tested by the method given in Part 2 of this standard the paper shall meet the requirements given in Tables 5 to 8.

5.2 Any dyes used for colouring shall remain discernible after dying and/or impregnating and shall not interfere with the impregnation.

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*Rules for rounding off numerical values (*revised*).

†Specification for cellulosic papers for electrical purposes : Part 1 Definitions and general requirements.

TABLE 1 DESCRIPTIONS FOR CLASS 5A PAPERS

(*Clause* 2.2)

CLASS	SYMBOL	DESCRIPTION	FURTHER DESCRIPTION OF CLASS 5A PAPERS				REMARKS
			Conductivity of Aqueous Extract (mS/m)		Air Permeability μm/Pa.s		
			Symbol	Description	Symbol	Description	
5A	5A1	Kraft insulating paper, apparent density $\leq 0·75$ g/cm^3	−1	<4	L1	$\leq 0·005$	The 5A paper is a Class 1 kraft paper for users requiring a particularly high purity. Compared with the requirements of Section 1, intervals and air permeability values are more closely defined, the tensile strength increased and the heat stability defined more precisely.
					L2	$>0·005$ to $\leq 0·01$	
					L3	$>0·01$ to $\leq 0·02$	
					L4	$>0·02$ to $\leq 0·05$	
	5A2	Kraft insulating paper, apparent density $>0·75$ to $\leq 0·85$ g/cm^3			M1	$>0·05$ to $\leq 0·1$	
					M2	$>0·1$ to $\leq 0·2$	
					M3	$>0·2$ to $\leq 0·5$	
					H1	$>0·5$ to $\leq 1·0$	
	5A3	Kraft insulating paper apparent density $>0·85$ to $\leq 0·95$ g/cm^3			H2	$>1·0$ to $<2·0$	
					H3	$>2·0$ to $\leq 5·0$	
					H4	$>5·0$ to $\leq 8·0$	
					H5	$>8·0$	
	5A4	Kraft insulating paper, apparatus density $>0·95$ g/cm^3					

Example 5A1 — 1L3 = A paper of nominal apparant density $\leq 0·75$ g/cm^3 conductivity <4 mS/m and nominal air permeability $>0·01$ to $\leq 0·02$ μm/Pa.s.

TABLE 2 DESCRIPTIONS FOR CLASS 5B PAPERS

(*Clause* 2.2)

CLASS	SYMBOL	DESCRIPTION	FURTHER DESCRIPTIONS OF CLASS 5B PAPERS				REMARKS
			Conductivity of Aqueous Extract (mS/m)		Air Permeability μm/Pa.s		
			Symbol	Description	Symbol	Description	
5B	5B1	Kraft insulating paper, apparent density ≤0·75 g/cm^3	–2	<10	L1	≤0·005	The 5B paper is a Class 1 paper for users requiring high purity; compared with Section 1, intervals and air permeability values are more closely defined the tensile strength and the heat stability defined more precisely.
					L2	>0·005 to ≤0·01	
					L3	>0·01 to ≤0·02	
					L4	>0·02 to ≤0·05	
	5B2	Kraft insulating paper, apparent density >0·75 to ≤0·85 g/cm^3			M1	>0·5 to ≤0·1	
					M2	>0·1 to ≤0·2	
					M3	>0·2 to ≤0·5	
					H1	>0·5 to ≤1·0	
	5B3	Kraft insulating paper, apparent density >0·85 to ≤0·95 g/cm^3			H2	>1·0 to ≤2·0	
					H3	>2·0 to ≤5·0	
					H4	>5·0 to ≤8·0	
					H5	>8·0	
	5B4	Kraft insulating papers, apparent density >0·95 g/cm^3					

Example : 5B2 — 2H1 = A paper of nominal apparent density >0·75 to ≤0·85 g/cm^3, conductivity <10 mS/m and nominal air permeability >0·5 to ≤1·0 μm/Pa.s.

TABLE 3 DESCRIPTIONS FOR CLASS 5C PAPERS

(*Clause* 2.2)

CLASS	SYMBOL	DESCRIPTION	FURTHER DESCRIPTIONS OF CLASS 5C PAPERS				REMARKS
			Conductivity of Aqueous Extract (mS/m)		Air Permeability μm/Pa.s		
			Symbol	Description	Symbol	Description	
5C	5C1	Kraft insulating paper, apperent density $\leqslant$0·75 g/cm^3	−3	<12·0	M2	>0·1 to $\leqslant$0·2	The 5C paper is a Class 1 paper for users requiring normal purity and medium or high air permeability and restricted water absorption.
					M3	>0·2 to $\leqslant$0·5	
					H1	>0·5 to $\leqslant$1·0	
					H2	>1·0 to $\leqslant$2·0	
	5C2	Kraft insulating paper, apparent density >0·75 to $\leqslant$0·85 g/cm^3			H3	>2·0 to $\leqslant$5·0	
					H4	>5·0 to $\leqslant$8·0	
					H5	>8·0	

Example : 5C1—3H2 = A paper of nominal apparent density $\leqslant$0·75 g/cm^3 conductivity <12 mS/m and nominal air permeability >1·0 to $\leqslant$2·0 μm/Pa.s.

TABLE 4 DESCRIPTION FOR CLASS 5D PAPERS

(*Clause* 2.2)

CLASS	SYMBOL	DESCRIPTION	FURTHER DESCRIPTION OF CLASS 5D PAPERS				REMARKS
			Conductivity of Aqueous Extract (mS/m)		Air Permeability μm/Pa.s		
			Symbol	Description	Symbol	Description	
5D	5D1	Kraft insulating paper, apparent density $\leqslant 0{\cdot}75$ g/cm^3	-2	<10	L M H	$\leqslant 0{\cdot}05$ $>0{\cdot}05$ to $\leqslant 0{\cdot}5$ $>0{\cdot}5$	The 5D paper is a Class 1 paper for users requiring a medium purity with increased machine direction orientation of the fibres
	5D2	Kraft insulating paper, apparent density $>0{\cdot}75$ to $\leqslant 0{\cdot}85$ g/cm^3					
	5D3	Kraft insulating paper, apparent density $>0{\cdot}85$ g/cm^3					
	5D71	Manila paper, apparent density $\leqslant 0{\cdot}75$ g/cm^3					
	5D72	Manila paper, apparent density $>0{\cdot}75$ to $\leqslant 0{\cdot}85$ g/cm^3					
	5D73	Manila paper, apparent density $>0{\cdot}85$ g/cm^3					
	5D81	Manila/kraft mixture paper, apparent density $\leqslant 0{\cdot}75$ g/cm^3					
	5D82	Manila/kraft mixture paper, apparent density $>0{\cdot}75$ to $\leqslant 0{\cdot}85$ g/cm^3					
	5D83	Manila/kraft mixture paper, apparent density $>0{\cdot}85$ g/cm^3					

Example : 5D81 — 2M = A paper of nominal density $\leqslant 0{\cdot}75$ g/cm^3, conductivity <10 mS/m, and a nominal air permeability $>0{\cdot}05$ to $\leqslant 0{\cdot}5$ μm/Pa.s.

TABLE 5 REQUIREMENTS FOR CLASS 5A PAPERS

(*Clause* 5.1)

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
1.	Thickness (*see* Note)	3	µm	Tolerance on Nominal Thickness Thickness (µm) — Tolerance, percent $\leqslant$ 75 — ±10 $\leqslant$ 75 to 105 — ± 7 >105 to $\leqslant$125 — ± 6 >125 — ± 4	By agreement between the purchaser and the supplier more than one layer may be used for measurements otherwise in accordance with IS : 1060 (Part 1) - 1966†
2	Substance (grammage) (*see* Note)	4	g/m^2	Tolerance on Nominal Thickness Substance — Tolerance, percent $\leqslant$ 45 g/m^2 — ±10 > 45 g/m^2 — ± 5	
3.	Apparent density (*see* Note)	5	g/cm^3	Tolerance ± 0·05 g/cm^3 on the nominal value	
4.	Tensile strength expressed as tensile index	6	Nm/g	Air permeability Class — Machine direction (minimum) — Cross direction (minimum) L — 98 — 37 M — 93 — 35 H 1-2 — 93 — 34 >H 3 — 88 — 34	To calculate tensile strength use the expression. $X = \frac{Y \times W}{10^3}$

NOTE — Purchaser and supplier shall agree which two of these three properties are mandatory.

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*Specification for cellulosic papers for electrical purposes Part 2 Methods of test.

†Methods of sampling and test for paper and allied products: Part 1 (*revised*)

(*Continued*)

TABLE 5 REQUIREMENTS FOR CLASS 5A PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
					where X = tensile strength kN/m, Y = tensile index Nm/g, and W = substance g/m^2.
5.	Elongation	6	percent	Machine direction : 2·0 (*Min*) Cross direction : 4·0 (*Min*)	
6.	Internal tearing strength expressed as tear factor	7	—	Minimum Values Substance g/m^2 — Machine direction — Cross direction >30 to $\leqslant 80$ — 500 — 600 >80 to $\leqslant 120$ — 600 — 700 >120 — 800 — 900	
7.	Moisture content	11	percent	Maximum 8·0	
8.	Ash	12	percent	Maximum 0·5	
9.	Conductivity of aqueous extract	13	mS/m	Maximum 4·0	

10.	*p*H of aqueous extract	14	–	6·0-8·0	
11.	Air permeability	17	µm/Pa.s	When a value of air permeability is specified by the purchaser, the air permeability shall not deviate from this value by more than ± 33 percent, when a purchaser orders by the code, the value shall be within the range allotted to that code	
12.	Water absorption Klemm method	20	mm	Air permeability symbol M and H ⩾10 L ⩾ 5	
13.	Electric strength ac	22	kV/mm	Type — Air Permeability Symbol: L, M, H1, H2-H5 (Minimum values) 5A1: —, 7·0, 7·0, 6·5 5A2: 8·0, 7·5, 7·0, 7·0 5A3: 8·5, 8·0, 7·0, 7·0 5A4: 9·0, 8·0, 7·5, 7·5	The electric strength is determined at room temperature after drying the paper at 105°C for 1-2 h and within 2 min of removal from the oven

*Specification for cellulosic papers for electrical purposes: Part 2 Methcds of test.

(*Continued*)

TABLE 5 REQUIREMENTS FOR CLASS 5A PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1981*	UNIT	REQUIREMENTS	REMARKS
14.	Dissipation factor of askarel heated with paper Using askarel having Tan δ, 0·05 at 90°C and 50H2 maximum	Test matter under remarks		Maximum 0·2	The measurement of electrical dissipation factor of askarels, changed by chemical ingredients of paper, is an optional test when agreed between purchaser and the supplier. The askarel type is chosen generally according to an agreement between purchaser and supplier. *Test apparatus and test liquid* a) A wide mouth 250 cm^3 conical flask with a hollow ground-in stopper is cleaned thoroughly (toluene, chemical securing powder, tap water, distilled water, pure methanol), dried (12 h at 105 ± 2·5°C in an oven naturally ventilated) and cooled down to room temperature above silica gel in a desiccator.

b) A test cell for measuring the electrical dissipation factor of insulating liquids according to IS : 6262-1971† cleaned in the same way as in (a) It is stored in an oven at 105 ± 2 5°C until it is used

c) New askarel is used for the test The dissipation factor of the askarel should not be above 0 05, measured in the test cell of (b) If the dissipation factor exceeds that value the askarel is to be treated with bleaching clay.

Procedure

a) 5 ±0 5 g of air dried paper are cut into strips of about 1 × 2 cm and put into the conical flask For this work the hands should be covered with dispossible polyethylene gloves, the cutting device must be clean.

The test piece is dried 24 h at 105 ± 2 5°C in an oven as mentioned above and cooled down to room temperature above silica gel in a desiccator.

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*Specification for cellulosic papers for electrical purposes. Part 2 Methods of test

†Method of test for power factor and dielectric constant of electrical insulating liquids.

(*Continued*)

TABLE 5 REQUIREMENTS FOR CLASS 5A PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1981*	UNIT	REQUIREMENTS	REMARKS
					b) The dried test piece is weighed to the nearest 0·1 g. Askarel weighing 40 times as much is added. The flask is closed with the stopper and stored at 105 ± 2·5°C for 7 days in an oven as mentioned before. After this treatment the electrical dessipation factor of the decanted askarel is measured at 90°C in the prepared test cell.
15.	Heat stability	25	percent	*120°C/7 days*	
				Degree of polymerization : *Max* decrease 50 percent	Values given are for papers >70 µm in thickness
				Tear strength under consideration	
				Conductivity of aqueous extract : *Max* increase to 23 mS/m	
				Bursting strength : *Max* decrease 20 percent	

*Specification for cellulosic papers for electrical purposes: Part 2 Methods of test.

TABLE 6 REQUIREMENTS FOR CLASS 5B PAPERS

(*Clause* 5.1)

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
1.	**Thickness** (*See* Note)	3	μm	Tolerance on Nominal Thickness Thickness (μm) — Tolerance, percent ≤75 — ± 10 ≤ 75 to 105 — ± 7 >105 to ≤125 — ± 6 >125 — ± 4	By agreement between purchaser and supplier more than one layer may be used for measurements in accordance with IS :1060 (Part 1) - 1966†.
2.	Substance (grammage) (*See* Note)	4	g/m^2	Tolerance on Nominal Substances Substance — Tolerance, percent ≤ 45 g/m^2 — ± 10 > 45 g/m^2 — ± 5	
3.	Apparent density (*See* Note)	5	g/cm^3	Tolerance ± 0·05 g/cm^3 on the nominal values	
4.	Tensile strength expressed as tensile index	6	Nm/g	Air Permeability Class — Machine Direction *Min* — Cross Direction *Min* L — 98 — 37 M — 93 — 35 H 1-2 — 93 — 34 >H 3 — 88 — 34	To calculate tensile strength use the expression: $X = \frac{Y \times W}{10^3}$ where X = tensile strength, kN/m Y = tensile index, Nm/g W = substance, g/m^2

NOTE — Purchaser and supplier shall agree which two of these three properties are mandatory.

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*Specification for cellulsoic papers for electrical purposes : Part 2 Methods of test.

†Methods of sampling and test for paper and allied products: Part 1 (*revised*).

(*Continued*)

TABLE 6 REQUIREMENTS FOR CLASS 5B PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
5.	Elongation	6	percent	Machine direction : 2·0 *Min* Cross direction : 4·0 *Min*	
6.	Internal tearing strength expressed as tear factor	7	—	Substance g/m² — Minimum Values: Machine direction, Cross direction >30 to ⩽80 — 500, 600 >80 to⩽120 — 600, 700 >120 — 800, 900	
7.	Moisture content	11	percent	Maximum 8·0	
8.	Ash	12	percent	Maximum 1·0	
9.	Conductivity of aqueous extract	13	mS/m	Maximum 10·0	
10.	*p*H of aqueous extract	14	—	6·0 to 8·0	
11.	Air permeability	19	µm/Pa.s	When a value of air permeability is specified by the purchaser, the air permeability shall not deviate from this value by more than ± 33 percent. When a purchaser orders by the code, the value shall be within the range allotted to that code.	

12.	**Water absorption (klemm method)**	20	mm	Air Permeability Symbol M and H >10 L > 5	
13.	**Electric strength** **ac**	22	kV/mm	Type — Air permeability symbol L, M, H1, H2-5 (minimum values) 5B1: –, 7·0, 7·0, 6·0 5B2: 8·0, 7·5, 7·0, 7·0 5B3: 8·5, 8·0, 7·0, 7·0 5B4: 9·0, 8·0, 7·5, 7·5	The electric strength is determined either: a) at 90°C the paper having been dried at this temperature for 50-60 min; b) at room temperature after drying the paper at 105°C for 1-2 h and within 2 min of removal from the oven.
14.	**Dissipation factor of askarel heated with paper**			Using askarel of Tan 0·2 (*Max*)	The measurement of electrical dissipation factor of askarels, changed by chemical ingredients of paper, is an optional test when agreed between purchaser and supplier. The askarel type is chosen generally according to an agreement between purchaser and supplier. *Test apparatus and test liquid* a) A wide mouth 250-cm³ conical flask with a hollow ground-in stopper is cleaned thoroughly (toluene, chemical scouring powder, tap water, distilled water, pure methanol), dried (12 h at 105 ± 2·5°C in an oven naturally ventilated) and cooled down to room temperature above silica gel in a desiccator.

*Specification for cellulosic papers for electrical purposes: Part 2 Methods of test.

(*Continued*)

TABLE 6 REQUIREMENTS FOR CLASS 5B PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
					b) A test cell for measuring the electrical dissipation factor of insulating liquids according to IS 6262-1971† cleaned in the same way as in (a). It is stored in an oven at 105 ± 2.5°C until it is used. c) New askarel is used for the test. The dissipation factor of the askarel should not be above 0.05 measured in the test cell. If the dissipation factor exceeds that value the askarel is to be treated with bleaching clay *Procedure* a) 5 ± 0.5 g of air dry paper are cut into strips of about 10 × 20 mm and put into the conical flask. For this work the hands should be covered with disposable polyethylene gloves, the cutting device must be clean The test piece is dried 24 h at 105 ± 2.5°C in an oven as mentioned above and cooled down to room temperature above silica gel in a desiccator

				120°C 7 days	b) The dried test piece is weighed to the nearest 0.1 g. Askarel weighing 40 times as much is added. The flask is closed with the stopper and stored at 105 ± 2.5 °C for 7 days in an oven as mentioned before. After this treatment the electrical dissipation factor of the decanted askarel is measured at 90°C in the prepared test cell
15	Heat stability	25	percent	Degree of polymerization *Max* decrease 50 percent Tear strength Under consideration Conductivity of aqueous extract *Max* increase to 23 mS/m. Bursting strength *Max* decrease 20 percent	Values given are for paper >78 µm in thickness

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*Specification for cellulosic papers for electrical purposes: Part 2 Methods of test.

†Methods of test for power factor and dielectric constant of electrical insulating liquids.

TABLE 7 REQUIREMENTS FOR CLASS 5C PAPERS

(*Clause* 5.1)

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
1.	Thickness (*See* Note)	3	µm	Tolerance on Nominal Thickness Thickness (µm) — Tolerance, percent ≤105 — ±10 >105 to ≤125 — ± 6 >125 — ± 4	By agreement between purchaser and supplier more than one layer may be used for measurements otherwise in accordance with IS : 1060 (Part 1) -1960†.
2.	Substance (grammage) (*See* Note)	4	g/m²	Tolerance on Nominal Substance Substance — Tolerance, percent ≤45 g/m² — ±10 >45 g/m² — ± 5	
3.	Apparent density (*See* Note)	5	g/cm³	Tolerance ± 0·05 g/cm³ on the nominal value	
4.	Tensile strength expressed as tensile index	6	Nm/g	— Machine direction MD — Cross direction CD M — 93 — 35 H 1-2 — 93 — 34 H3 — 88 — 34	To calculate tensile strength use the expression: $X = \frac{Y \times W}{10^3}$ where X = tensile strength, kN/m, Y = tensile index, Nm/g, and W = substance g/m².
5.	Elongation	6	percent	Machine direction : 2·0 *Min* Cross direction : 4·0 *Min*	

6.	Internal tearing strength expressed as tear factor			Minimum Values		
				Substance g/m^2	Machine direction	Cross direction
				> 30 to ⩽ 80	500	600
				> 80 to ⩽120	600	700
				> 120	800	900
7	Moisture content	11	percent	Maximum 8 0		
8	Ash	12	percent	Maximum 1 0		
9	Conductivity of aqueous extract	13	mS/m	Maximum 12		
10.	pH of aqueous extract	14	—	6 0 to 8 0		
11	Air permeability	19	μm/Pa s	When a value of air permeability is specified by the purchaser, the air permeability shall not deviate from this value by more than ± 33 percent. When a purchaser orders by the code, the value shall be within the range allotted to that code.		

Note — Purchaser and supplier shall agree which two of these three properties are mandatory

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*Specification for cellulosic papers for electrical purposes Part 2 Methods of test.

†Methods of sampling and test for paper and allied products, Part 1

(*Continued*)

TABLE 7 REQUIREMENTS FOR CLASS 5C PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2)-1982*	UNIT	REQUIREMENTS	REMARKS
12.	Water absorption (Klemm method)	20	mm	Nominal values $\leqslant 70$ μm to $\leqslant 15$ >70 μm to $\leqslant 25$	
	Heat stability	25	percent	120°C/7 days Degree of polymerization : *Max* decrease 50 percent Tear strength : 30 percent *Max* reduction Conductivity of aqueous extract : *Max* increase to 20 mS/m	Values given are for papers >70 μm in thickness
13	Electrical strength	22	kV/mm	Air Permeability Symbol Type M H1-2 $>H_3$ 5C1 7 7 6·5 5C2 75 7 7	

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*Specification for cellulosic papers for electrical purposes. Part 2 Methods of test

TABLE 8 REQUIREMENTS FOR CLASS 5D PAPERS

(*Clause* 5.1)

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (Part 2)-1982*	UNIT	REQUIREMENT	REMARKS
1.	Thickness (*See* Note)	3	μm	Tolerance on Nominal Thickness Thickness (μm) — Tolerance, percent ⩽105 — ±10 >105 to ⩽125 — ±10 >125 — ±10	By agreement between purchaser and supplier more than one layer may be used for measurements in accordance with IS : 1060 (Part 1) - 1966†.
2.	Substance (*See* Note)	4	g/m²	Tolerance on Nominal Substance Substance — Tolerance, percent ⩽45 g/m² — ±10 >45 g m² — ± 8	
3.	Apparent density (*See* Note)	5	g/cm³	Tolerance ± 0·05 g/cm³ on the nominal value	
4.	Tensile stress expressed as tensile index	6	Nm/g	Symbol — Machine direction (*Min*) — Cross direction (*Min*) 5D1 , 5D2, 5D3 — 123 — – 5D71, 5D72, 5D73 — 140 — – 5D82, 5D83 — 135 — –	To calculate tensile strength, use the expression : $X = \frac{Y \times W}{10^3}$

NOTE — Purchaser and supplier shall agree which two of these three properties are mandatory.

*Specification for cellulosic papers for electrical purposes: Part 2 Methods of test.

†Methods of sampling and test for paper and allied products, Part 1 (*revised*).

(*Continued*)

TABLE 8 REQUIREMENTS FOR CLASS 5D PAPERS — *Contd*

SL No.	PROPERTY	TEST METHOD ACCORDING TO IS : 9335 (PART 2) 1982*	UNIT	REQUIREMENT	REMARKS
					where X = Tensile strength, kN/m, Y = Tensile index, Nm/g, and W = Substance, g/m².
5.	Elongation	6	percent	Machine direction: 2·0 *Min* Cross direction : 4·0 *Min*	45 g/m² 1·7 3·4
6.	Internal tearing strength expressed as tear index	7	—	Minimum values: 5D1, 5D2, 5D3, 5D81, 5D82 Substance g/m² — Machine Direction 30 to 80 — 300 80 to120 — 400 120 — 500 Minimum values: 5D71 and 5D72 Substance g/m² — Machine Direction 30 to 80 — 350 80 to 120 — 450 120 — 550	
7.	Moisture content	11	percent	Maximum 8·0	
8.	Ash	12	percent	Maximum 1·0	
9.	Conductivity of aqueous extract	13	mS/m	Maximum 10·0	

10.	*p*H of aqueous extract	14	–	6·0-8·0	
11.	Air permeability	19	µm/Pa.s	When a value of air permeability is specified by the purchaser, the air permeability shall not deviate from this value by more than ± 33 percent. When a purchaser orders by the code, the value shall be within the range allotted to that code.	
12.	Water absorption (Klemm method)	20	mm	Air Permeability Symbol M and H >10 L $\ngtr 5$	
13.	Electric strength ac	22	kV/mm	Air permeability symbol: L M H Types (Minimum values) 5D1, 5D71, 5D73: – 6·5 6·0 5D2, 5D72, 5D82: 8·0 6·5 6·0 5D3, 5D82, 5D83: 8·5 7·0 6·5	The electric strength is determined either (a) at 90°C, the paper having been dried at this temperature for 30 to 60 min; or (b) at room temperature after drying the paper at 105°C for 1 to 2 h and within 2 min of removal from the oven.
14.	Dissipation factor for impregnated paper	23		at 115°C : 0·025 (*Max*)	
15.	Heat stability	25	percent	120°C/75 days Degree of polymerization Tear strength Conductivity of aqueous extract } Under consideration	

*Specification for cellulosic papers for electrical purposes: Part 2 Methods of test.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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